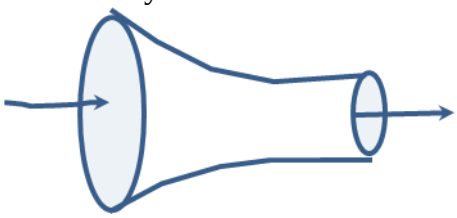
Tutorial -3 (unsteady flow process)

1. Two kg of water at 500 kPa, 20°C is heated in a constant pressure process (SSSF) to 1700°C. Find the best estimate for the heat transfer. (6.15) Ans: 12849 kJ

2. A mixing chamber with heat transfer receives 2 kg/s of R-22 at 1 MPa, 40°C in one line and 1 kg/s of R-22 at 30°C, quality 50% in a line with a valve. The outgoing flow is at 1 MPa, 60°C. Find the rate of heat transfer to the mixing chamber. (6.16) Ans. 148.66 kW

3. Superheated vapor ammonia enters an insulated nozzle at 20°C, 800 kPa, shown in Fig. P6.19, with a low velocity and at the steady rate of 0.01 kg/s. The ammonia exits at 300 kPa with a velocity of 450 m/s. Determine the temperature

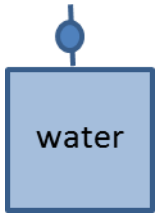


(or quality, if saturated) and the exit area of the nozzle. (6.19) Ans: 0.947, 8.56e-6 m^2

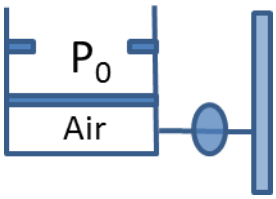
4. A rigid 100-L tank contains air at 1 MPa, 200°C. A valve on the tank is now opened and air flows out until the pressure drops to 100 kPa. During this process, heat is transferred from a heat source at 200°C, such that when the valve is closed, the temperature inside the tank is 50°C. What is the heat transfer? (6.48) Ans: 25.7 kJ

5. A 1-m^3 tank contains ammonia at 150 kPa, 25°C. The tank is attached to a line flowing ammonia at 1200 kPa, 60°C. The valve is opened, and mass flows in until the tank is half full of liquid, by volume at 25°C. Calculate the heat transferred from the tank during this process. (6.51) Ans: **-379666 kJ**

6. A 2-m^3 insulated vessel, shown in Fig. P6.57, contains saturated vapor steam at 4 MPa. A valve on the top of the tank is opened, and steam is allowed to escape. During the process any liquid formed collects at the bottom of the vessel, so that only saturated vapor exits. Calculate the total mass that has escaped when the pressure inside reaches 1 MPa. (6.57) Ans: 27.24 kg



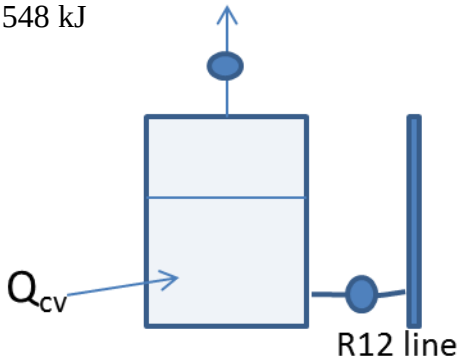
7. A mass-loaded piston/cylinder, shown in Fig. P6.63, containing air is at 300 kPa, 17°C with a volume of 0.25 m^3, while at the stops $V = 1$ m^3. An air line, 500 kPa, 600 K, is connected by a valve that is then opened until a final inside pressure of 400 kPa is reached, at which point $T = 350$ K. Find the air mass that enters, the work, and heat transfer. (6.63) Ans: 3.082kg, 225kJ, -819.2 kJ



8. An elastic balloon behaves such that pressure is proportional to diameter and the balloon contains 0.5 kg air at 200 kPa, 30°C. The balloon is momentarily connected to an air line at 400 kPa, 100°C. Air is let in until the volume doubles,

during which process there is a heat transfer of 50 kJ out of the balloon. Find the final temperature and the mass of air that enters the balloon. (6.64) Ans: .2175 m^3, 43.4C, 0.707 kg

9. A rigid tank initially contains 100 L of saturated-liquid R-12 and 100 L of saturated-vapor R-12 at 0°C. A valve on the bottom of the tank is connected to a line flowing R-12 at 10°C, 900 kPa. A pressure-relief valve on the top of the tank is set at 745 kPa (when tank pressure reaches that value, mass escapes such that the tank pressure cannot exceed 745 kPa). The line valve is now opened, allowing 10 kg of R-12 to flow in from the line, and then this valve is closed. Heat is transferred slowly to the tank, until the final mass inside is 100 kg, at which point the process is stopped.
a) How much mass exits the pressure-relief valve during the overall process?
b) How much heat is transferred to the tank? (6.67) Ans: 51.47 kg, 11548 kJ



10. A cylinder with a constant load on the piston contains water at 500 kPa, 20 °C and volume of 1 L. The bottom of the cylinder is connected with a line and valve to a steam supply line carrying steam at 1 MPa, 200 °C. The valve is now opened for a short time to let steam in to a final volume of 10 L. The final uniform state is two phase and there is no heat transfer in the process. What is the final mass inside the cylinder? (6.68) Ans: 1.276 kg